Method for calculating/optimizing the diameter of a paper or board web reel

The invention relates to a method according to the preamble of claim 1.

In paper and board machines a finished web is wound into machine reels which are sought to be run to a certain, usually a maximum diameter so as to be as large as possible in size. These machine reels are run on a slitter-winder to form customer rolls, whose desired diameter and width are determined according to the customer's demand. In other words, rolls having a width and a diameter as desired by the customer are slit out of the full-width web of the machine reel by means of the slitter-winder. One problem in connection with the methods used in prior art is that if there occur web breaks in the paper machine, the diameter of the machine reel changes.

In the prior art there is known a so-called continuous-trimming running mode in which machine reels are wound into a maximum diameter regardless of customer roll diameters except in the case of grade change. On the slitter-winder, splicing is accomplished to join machine reels to one another in order to obtain customer rolls of desired diameter size. Previously, splicing was performed manually and it was troublesome and difficult, the quality of splices varied and did not meet the requirements of printing houses. Today, there is also available an automatic splicing device, which has the advantage that the diameter of the machine reel need be optimized not according to individual sets but according to the entire order for a specific paper grade. However, it is problematic in this connection that, for reasons of the runnability of the printing press primarily with a view to minimizing breaks, it is required by the printing houses that if there are splices in customer rolls their number and location shall be as specified. In that connection, in the continuous-trimming running mode, it must be possible to calculate already in connection with the winding of the machine reel the location and the number of

the splices caused by the joining of the ends of the webs of different machine reels to produce customer rolls of the right size so that the splices will be at the right location in the customer roll to be wound in order that it shall meet the criteria set by the customer and the amount of broke shall be minimized. The printing houses require, for example, that there shall be no splice at a given distance from the roll bottom or from the roll surface.

Previously, a manually calculated table was used concerning the effect of the customer roll diameter and the number of sets on the diameter of the machine reel. After that, automatic systems have been created to calculate the above-mentioned matters, in which it is additionally possible to take into account the effect of bad paper in the reel and different/varying winding tension as well as the thickness of paper both in the machine reel and in the customer roll and in which it is possible to take into account the content and size of machine reels placed in intermediate storage. This kind of procedure is described, for example, in the paper *Paper Machine Reel Optimization – Analysis and a Case Study* read by *Dusan Dapcevic* and published on pages C37 – C45 of the conference publication: Conference Record of the 1999 IEEE Annual Pulp & Paper Industry Technical Conference; Seattle, WA, June 21-25, 1999; 1-10.

An object of the invention is to provide a method in which the drawbacks of the arrangements known from the prior art are eliminated or at least minimized and in which the above-noted objects are achieved.

With a view to achieving the objects described above as well as those coming out later, the method according to the invention is mainly characterized by what is stated in the characterizing part of claim 1.

In connection with the invention, the continuous-trimming running mode known per se is used as the running mode on the slitter-winder so that attempts are made to run machine reels of maximum size within the limits set by technology and

economy, and the method in accordance with the invention determines/optimizes the machine reel diameter based on the printing houses' restrictions *Roll Paper Requirements and Specifications*, Version 1.4, June 16, 2000, Quebecor World Roll Paper Requirements and Specifications or on converters' restrictions (*Smurfit-Stone, Containerboard Mechanical Roll Quality Standards*, 888 – 284 – 4470, Effective Date, June 1, 2001) on the splice location in the customer roll. The diameter determined in the method in accordance with the invention is fed manually or automatically to the reel-up to control the reel-up.

In the method in accordance with the invention, the restrictions on the splice location are set as settable variables, for example, according to each individual paper grade or printing house/order. At the same time, the number of splices to be placed in customer rolls and the resultant machine reel broke, caused because of the joining of machine reels to one another, are optimized. The system in accordance with the invention also takes into account the undersize machine reels produced because of web breaks and the optimization of the location of the splice used for joining them.

The method in accordance with the invention provides, for example, a proposal for changing the slitting order of machine reels on the slitter-winder if the paper grade and the customer roll diameters allow it, whereby the splice can be placed in the customer roll at a location allowed by the printing house.

The application of the method in accordance with the invention can be a so-called stand-alone system, i.e. a separate system, or a part of the other production control system known per se.

The method in accordance with the invention makes it possible to improve material efficiency such that a maximum proportion of the paper produced on the paper machine can be wound into customer rolls in spite of the different restrictions

concerning splices and roll diameters. In this way, material efficiency, i.e. the net efficiency achieved on the machine, is improved by means of the invention.

In the following, the invention will be described in greater detail with reference to the figures in the appended drawing, but the invention is not by any means meant to be narrowly limited to the details of them.

Figure 1 schematically shows calculation/optimization of machine reel diameters.

Figure 2 schematically shows the effect of optimization of the location of the splice joining machine reels on broke length.

Figure 3 schematically shows optimizing the location of the splice joining a web-break machine reel.

Figure 4 is a schematic block diagram of calculation/optimization of machine reel diameters in a machine reel change/web-break situation.

As shown in Fig. 1, the information needed for calculation/optimization of machine reel diameters is obtained from a production control system 11, which provides, among other things, information about the next orders for the slitter-winder for the purpose of optimizing the diameter of the next machine reel, as well as the number of sets, customer roll diameters, web length in the roll, slitter-winder settings and other corresponding information. Based on this information, a diameter instruction 12 for the machine reel is calculated/optimized and freely settable splice location restrictions in the customer roll are obtained for a reel-up control system 13, thereby obtaining a maximum reel diameter instruction for the reel-up, unless according to calculation a splice is located in the last set in a forbidden area in the customer roll. If this is the case, the diameter instruction is reduced such that the splice will be located at a sufficient distance inside the customer roll according to calculation. In other words, the available information is used in the

control system 13 of the reel-up, which gives a machine reel diameter instruction for running.

As shown in Fig. 2, the effect of optimization of the location of the splice joining machine reels on broke length is significant. In the example of Fig. 2, the maximum length in a completed machine reel is initially 77 km. The desired number of customer rolls is 6 and their web length is 13 km. The system finds that with the machine reel diameter that is being run a splice will be placed too close to the surface in the roll of the last set in view of the restrictions set by the customer. Consequently, the system reduces the length of the machine reel to 75 km, so that the splice will be at a sufficient distance from the surface of the roll, thus achieving a web saving of 2 km, i.e. 2.6 % more material efficiency.

Fig. 3 shows optimization of the location of the splice joining a web-break machine reel. In the example shown in Fig. 3, the length of the web-break machine reel is 51 km. 4 customer rolls of 13 km each are needed. The system finds that, as a result of a web break on the paper machine, the splice will be placed too close to the surface in the roll of the last set, with the result that the system gives an instruction to wind the next machine reel such that it will leave a bottom of 1.5 km for the last set, which means that the splice will be far enough from the bottom of the roll to which the preceding splice machine reel is joined, the running order of the machine reels at the slitter is changed. In this way, a 2.9 % saving in the material of the machine reel is achieved with the new machine reel length of 75 km.

In the block diagram shown in Fig. 4, the block 21 contains order list information; customer roll diameter (tolerances), core diameter, numbers of sets, and information about the restrictions on machine reel dimensions; web length/ diameter. The necessary information about the restrictions on the location of a splice in the customer roll (e.g. from the surface/bottom) is given in the block 22. The block 23 receives information from the block 21 and addition information for the next machine reel, and the surface area of the bottom set of the machine reel to be wound

and its diameter on the core are calculated by means of a method known per se in the block 23 (surface area of the machine reel – (surface area of the addition of the preceding bottom set + X * surface area of full sets + surface area of the reeling drum)). In the above calculation formula, by the surface area is meant the surface area of the end face of a cylinder or circle corresponding to a reel/roll and X = the maximum number of full sets obtained from the machine reel in question. In the block 24, the result received from the block 23 is compared with the information received from the block 22 concerning the restrictions on the splice location in the customer roll, if the splice location is OK, a transition is made to the block 25, where it is calculated how much additional surface area is needed in order that an undersize bottom set shall become full (addition to the surface of the next machine reel) and the information is transmitted further back to the block 23. If the splice is too close to the bottom, the machine reel diameter is reduced to the preceding full set according to the block 26 in order to receive addition information = 0 as a result, and the information is transmitted further back to the block 23. If the splice is too close to the surface in the block 27, the machine reel diameter is reduced such that the splice will be placed deep enough from the surface. The information obtained from the block 27 is transmitted to the block 23. In accordance with the block diagram, in a machine reel change/web-break situation, the calculation/optimization of the machine reel diameter, in a reel change/web-break situation, the calculation/optimization of the machine reel diameter takes place such that the length (surface area of the end face) of the bottom set of the last completed machine reel (undersized) is stored in the memory of the system. The diameter of the bottom set of the next machine reel (undersized) is calculated, block 23, according to this value and the lengths (end-face surface areas) of the next sets in accordance with the order list 21, assuming that the reel will be one with a maximum diameter.

The calculated bottom set diameter is compared, block 24, with the splice location restrictions 22 (e.g. from the bottom and the surface of the customer roll) fed into the system.

- The bottom splice restriction is found directly on the basis of diameter. If calculation shows that the splice will be placed too close to the bottom in a customer roll of an undersize surface set, block 26, the system reduces (when needed, the operator confirms the change) the target diameter of the machine reel which is building up such that an undersized bottom set is not wound into said machine reel.
- The surface splice restriction is found by comparing the calculated diameter of the undersize bottom set with the diameter of the set in question according to the order list. If calculation shows that the splice will be placed too close to the surface in a customer roll of an undersize surface set, block 27, the system reduces (when needed, the operator confirms the change) the target diameter of the machine reel which is building up such that in the undersize surface set the splice will be placed at least at a distance according to the restriction from the surface.

If there occurs a web break during the reeling of the machine reel, the system calculates the diameter of the undersize surface set of said machine reel, block 23, and checks the splice location restrictions, block 24. If the restriction is not violated, block 25, the system proceeds with the calculation of the next machine reel, as described above. If the restrictions are violated, the system proposes a change in the running order of machine reels or waste pulping.

Above, the invention has been described only with reference to some of its advantageous exemplifying embodiments, but the invention is not by any means intended to be narrowly limited to the details of them.